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such an impression will not depart from the reader's mind. Such an interest and such a temper hardly conduce now to a valid understanding of the problems of our present social structure. To be sure, this present volume is concerned mainly with the elucidation of the formula, not with its concrete applications. It may be that the further exploration of the practical insight afforded by the concept of productive duality, which the author promises, will do much to mitigate this impression of dialectic futility and abstractness.

This partially negative judgment should not, however, be the last word. It is a very substantial and much needed achievement to have given the careful exposition of Natorp's, Münsterberg's, and Baldwin's systems, to have given a fine portrayal and interpretation of the Thomistic synthesis, to have subjected "Great Objectivism" to a remarkably clear and acute analysis and criticism, and everywhere, to see into the motives, the difficulties, and the deeper points of contact between the major types of philosophic thinking. This value remains whatever be the worth of the author's own ingenious system and solution.

GEORGE P. ADAMS.

THE UNIVERSITY OF CALIFORNIA.

The Origin and Evolution of Life. By HENRY FAIRFIELD OSBORN. New York, Charles Scribner's Sons, 1917.—pp. xxi, 322.

This book furnishes a remarkable survey of evolution from the precellular stage of the bacteria and their forerunners to the higher mammals. It is as remarkable for its contribution to scientific hypothesis as for its mastery of data. It shows the distance, in both respects, that biological science has traveled since Darwin. It begins with the chemical analysis of life and describes the inorganic preparation for life in our solar system and on our planet. On the latter point the author is in substantial agreement with Professor Lawrence J. Henderson. Against a background of "perhaps a hundred million years" the author arranges the available material, particularly the paleontological evidence to which he is a distinguished contributor, into a wonderful story which gives the reader the impression of a great epic, more fascinating to us today than the mythology of *Paradise Lost*. It gives us indeed an appreciation of the poetry of science, at the same time that it shows that "imagination itself is strictly limited to recombinations of ideas which have come through observation," and that any theory to be of value must rest upon "experiment, observation and research, guided by imagination and checked by verification." Throughout, the author manifests a candor

and open-mindedness which might well make him a model to our too sectarian philosophers of today. It is of course impossible in this review to notice more than a few theoretical considerations of especial importance for a philosophy of evolution.

The author adopts the physicochemical theory of the origin of life without being a materialist. "Without being either a *mechanist* or a *materialist*, one may hold the opinion that life is a continuation of the evolutionary process rather than an exception to the rest of the cosmos, because both mechanism and materialism are words borrowed from other sources which do not in the least convey the impression which the activities of the cosmos make upon us. This impression is that of limitless and ordered energy" (p. 3). The evolution of life is creative evolution. "As compared with stellar evolution, *living matter does not follow the old evolutionary order*, but represents a new assemblage of energies and new types of action, reaction, and interaction—to use the terms of thermodynamics—between the chemical elements which may be as old as the cosmos itself, unless they prove to represent an evolution from still simpler elements. . . . The evolutionary process now takes an entirely new and different direction, . . . essentially constructive. . . . It is a continuous creation or creative evolution" (pp. 4 and 5). The author does not regard it impossible that some new element may be discovered in life compounds. But it is "more probable that unknown principles of action, reaction, and interaction between living forms await such discovery." This is "adumbrated in the as yet partially explored activities of chemical messengers" (p. 6).

He does not regard the difference between the lowliest organisms and inorganic compounds so vast but what we may discover the bridge—"namely, whether it is solely physicochemical in its energies, or whether it includes a *plus* energy or element which may have distinguished life from the beginning" (p. 281). But in any case he holds that there is "positive disproof of an internal perfecting principle or entelechy which would impel animals to evolve in a given direction regardless of the direct, reversed, or alternating directions taken by the organism in seeking its life environment or physical environment" (pp. 277, 278). "The conclusive evidence against an *élan vital* or internal perfecting tendency, however, is that these characters do not spring autonomously at any one time; they may lie dormant or rudimentary for great periods of time. . . . They require something to call them forth, to make them *active*, so to speak" (p. 279). This arousing of a latent new character may be effected through chemical

messengers "by stimulating the transformation of energy at a specific point."

The author rejects emphatically the doctrine of chance which since Darwin has been fashionable with writers on evolution. "I have long maintained that this opinion is a biological dogma . . . which has gained credence through constant reiteration, for I do not know that it has ever been demonstrated through the actual observation of any evolutionary series" (p. 8). The question of law *versus* chance in the evolution of life is no longer a matter of opinion but of direct observation. "So far as law is concerned, we observe that the evolution of life forms is like that of the stars: their origin and evolution as revealed through paleontology go to prove that Aristotle was essentially right when he said that 'Nature produces those things which, being continually moved by a certain principle contained in themselves, arrive at a certain end'" (p. 9). But this end is no "supernatural or teleological interposition through an externally creative power," but a law immanent in the process itself.

Professor Osborn proposes as the fundamental law of life its determination through four energy complexes. "In each organism the phenomena of life represent the action, reaction and interaction of four complexes of physicochemical energy, namely, those of (1) the inorganic environment, (2) the developing organism (protoplasm and body-chromatin), (3) the germ or heredity-chromatin, (4) the life environment. Upon the resultant actions, reactions and interactions of potential and kinetic energy in each organism, selection is constantly operating wherever there is competition with the corresponding actions, reactions and interactions of other organisms" (p. 21). The Darwinian principle of natural selection is thus given a subordinate, though a real place. Since the beginning of life there has been competition of organisms with other organisms as well as the survival selection of the inorganic environment. But "selection is not a form of energy nor a part of the energy complex; it is an arbiter between different complexes and forms of energy; it antedates the origin of life as remarked by Henderson" (p. 20). To quote but one illustration of the inadequacy of Natural Selection as an explanatory principle: "The general fact that the slow-breeding elephants evolved very much more rapidly than the frequently breeding rodents, such as the mice and rats (*Muridæ*), is one of the many evidences that the rate of evolution may not be governed by the frequency of natural selection and elimination" (p. 271). Neither the origin nor the development of life-forms can be accounted for by this principle.

Special stress is laid throughout the book on the directing agency of the germ or heredity-chromatin: "It would appear, according to this interpretation, that the continuity of life since it first appeared in Archeozoic times is the continuity of the physicochemical energies of the chromatin; the development of individual life is an unfolding of the energies taken within the body under the directing agency of the chromatin; and the evolution of life is essentially the evolution of chromatin energies" (pp. 96, 97). The chromatin content of the nucleus is contrasted with the protoplasm and body-chromatin. "The chromatin content of such a nucleus is measured in the bulk of the chromosome rods of which it is composed" (p. 97). The marvels of the chromatin are dwelt upon: "The chromatin as the potential energy of form and function is at once the most conservative and the most progressive center of physicochemical evolution; it records the body forms of past adaptations, it meets the emergencies of the present through the adaptability to new conditions which it imparts to the organism in its distribution throughout every living cell, it is continually giving rise to new characters and functions. Taking the whole history of vertebrate life from the beginning, we observe that every prolonged old adaptive phase in a similar habitat becomes impressed in the hereditary characters of the chromatin. Throughout the development of new adaptive phases the chromatin always retains more or less potentiality of repeating the embryonic, immature and more rarely some of the mature structures of older adaptive phases in the older environment. This is the law of ancestral repetition" (p. 152). But the author admits that "the idea that the germ is an energy complex is an as yet unproved hypothesis, it has not been demonstrated" (p. 19). While it is supposed to be the presiding genius of all phases of development, we are ignorant as to how it accomplishes this. "We are equally ignorant as to how the chromatin responds to the actions, reactions and interactions of the body cells of the life environment, and of the physical environment, so as to call forth a new adaptive character, unless it be through some infinitely complex system of chemical messengers and other catalytic agencies" (p. 98). Surely a large bill of ignorance; and in the light of evidence it is questionable whether the author's emphasis on the chromatin and its sharp separation from protoplasm is justified. But he is in distinguished company.

As to the controversy between the Lamarckians and the pure Darwinians, the author takes a middle ground. The Lamarckians hold "*that the causes of the genesis of new form and new function are*

to be sought in the body cells" (p. 143). According to this "explanation a change of environment, of habit, and of function should always be antecedent to changes of form in succeeding generations." This would mean an increasing similarity in adults of antecedent generations which is not always the case. The pure Darwinian (Weismann and deVries) explanation, on the other hand, is "*that genesis of new form and function is to be sought in the germ cells or chromatin. . . .*" According to this explanation, body cell changes do not exert any corresponding specific influence on the germ cells" (p. 144). The predispositions that arise in the chromatin are conceived as lawless or experimental, fortuitous or chance variations upon which natural selection acts. But the Darwinian view is contradicted by paleontological evidence both in the Invertebrata and the Vertebrata where we "observe that continuity and law in chromatin evolution prevail over the evidence either of fortuity or sudden leaps or mutations, that in the genesis of many characters there is a slow and prolonged rectigradation or direct evolution of the chromatin toward adaptive ends" (p. 146). Neither theory meets entirely the facts presented by adaptive characters. These present three phases: "*First, the origin of character form and character function; second, the more or less rapid acceleration or retardation of character form and function; third the coördination and coöperation of character form and function. . . .*" It is certain that our search for causes must proceed along the lines of determining which actions, reactions and interactions invariably precede and which invariably follow those of the body cells (Lamarckian view) or those of the chromatin (Darwin-Weismann view)" (p. 145). The author is of the opinion that the causes of germ evolution "are internal-external rather than purely internal—in other words, that some kind of relation exists between the actions, reactions and interactions of the germ, of the organism, and of the environment" (p. 283). As there is a centrifugal action whereby certain cells of the reproductive glands affect, in an important way, all the body cells including the brain centers of intelligence, so it is likely that there is "a centripetal action whereby chemical messengers from any part of the body specifically affect the heredity germ and thus the new generation to which it will give rise."

Professor Osborn does not seem inclined to extend this theory to mental processes though he accords them an important rôle. "These profound and extremely ancient powers of animal life exert indirectly a *creative influence* on animal form, whether we adopt the Lamarckian or Darwinian explanation of the origin of animal life, or find elements

of truth in both explanations. The reason is that choice, discrimination, attention, desire for food, and other psychic powers are constantly acting on individual development and directing its course. Such action in turn controls the habits and migrations of animals, which influence the laws of *adaptive radiation* and of selection. In this indirect way these psychic powers are creative of new form and new function" (p. 114). But if it is true that "the body is an organic whole, and the so-called organs of internal secretion are not unique, but the bones, muscles, skin, brain, and every part of the body are furnishing internal secretions necessary to the development and proper functioning of all the other organs of the body" (pp. 289, 290), then it is not clear why the 'psychic powers' may not express themselves through the characteristic brain secretions and affect the germ cells centripetally as they are admittedly affected centrifugally by the secretions of the reproductive glands.

If the causes of evolution are obscure, the phenomenological sequences are becoming increasingly clear. "What we have gained during the past century is positive knowledge of the chief modes of evolution, we know almost the entire history of the transformation of many different kinds of mammals. These modes are distinguished from unknown *causes* as expressed in the following laws: first, the *law of continuity*; *natura non fecit saltum*; there is prevailing continuity in the change of form and proportion in evolution as in growth" (p. 251). Jennings has shown the graduated change in the protozoa. Perrin Smith, in the case of the cephalopod molluscs and the Triassic ammonites, "observes that the evolution of form continues uninterruptedly, even when there is no evidence whatever of environmental change. Conversely, environmental change does not necessarily induce evolution—for example during the Age of Mammals, although the mammals developed an infinite variety of widely different forms, the reptiles show very little change" (p. 137). This graduated character of change in the evolution of life was clearly expressed in the mutations of Waagen who discovered a complete fossil series of ammonites in 1869 and formulated Waagen's law: "It is that certain new characters arise definitely and continuously and, as Osborn has shown, adaptively" (p. 139). While the author recognizes discontinuous or saltatory mutations of the kind emphasized by de Vries, these amount to only a fifth or less for mammalian evolution. "Such mutations are attributable to sudden alternations of molecular and atomic constitution in the heredity-chromatin, or to the altered form of energy supplied to the chromatin during development" (p. 107).

The second law is "the *law of rectigradation*, under which many important new characters appear definitely and take an adaptive direction from the start" (p. 251). Thus we "observe in the characters springing from the heredity-chromatin a *predetermination* of another kind, namely, the origin through causes we do not understand of a tendency toward the independent appearance or birth at different periods of geologic time of *similar new and useful characters*," not in the ancestral body forms (pp. 251, 252). The discovery of this fact, with which the author's name is especially associated, is the strongest argument for law in evolution as opposed to blind chance.

The third law is "the *law of acceleration and retardation*, witnessed both in racial and individual development, whereby each character has its own velocity, or rate of development, which displays itself both in the time of its origin, in its rate of evolution and its rate of individual development" (p. 252). The last law underlies the profound changes of proportion as illustrated in mammals, as for example the long neck of the giraffe and the short neck of the elephant. Few new characters are observed to originate in mammals. The changes are due for the most part to loss of characters and changes in proportion. Indeed, as the author points out, "the chief quest of evolutionists today in every field of observation is the mode and cause of the origin and subsequent history of single characters" (p. 146). These he regards as determiners in the chromatin existing as an individual, potential and causal. An 'intruder' into either of the four energy complexes may produce a new or abnormal visible character type. The individuality of characters, their separate rate of movement and their coördination furnish today the bulk of descriptive explanation of life forms and functions. Their evolution exemplifies the law of compensation (p. 158). The special development of one character means the sacrifice of others as in the case of the extra toes of the horse. The sacrificed parts are never regained, and in this sense the chromatin evolution is irreversible. Reversal of adaptation must be regarded as "the reversal of function rather than of structure" (p. 198). Character evolution also exemplifies the laws of convergence and divergence (with radiation). "Widely separated descendants of similar ancestors may evolve in a closely but not entirely similar manner. The resemblances are due to the independent gain of similar new characters and loss of old characters. The differences are chiefly due to the unequal velocity of characters: in some lines certain characters appear or disappear more rapidly than in others" (p. 271).

But what accounts for these character changes? "The only vista

which we enjoy at present of a possible future explanation of the causes of character origin, character velocity, and character coöperation, is through chemical catalysis, namely through the hypothesis that all *actions* and *reactions* of form and motion liberate specific catalytic messengers, such as ferments, enzymes, hormones, chalones and other as yet undiscovered chemical messengers, which produce specific and coöperating *interactions* in every character complex of the organism and corresponding predispositions in the physicochemical energies of the germ; in other words, that the chemical accelerators, balancers and retarders of body cell development also affect the germ" (p. 150). It is in the field of interaction that somehow the efficient cause of character development must be found. The author distinguishes interaction from action and reaction. Interaction refers "to what is going on between material parts which are connected with each other by other parts, and cannot be analyzed at all by the two great dynamic principles alone without a knowledge of the structure which connects the interacting parts" (p. 15). We have been concerned mostly in the past with the interacting functions of nerve impulses. But latterly we are learning that "an interacting enzyme, hormone, or other chemical messenger circulating in the blood, may profoundly modify the growth of a great organism" (p. 15). The central theory which the author develops in his speculation on the origin and development of life, "is that every physicochemical action and reaction concerned in the transformation, conservation and dissipation of energy, produces also either as a direct result or as a by-product a *physicochemical agent of interaction which permeates and affects the organism as a whole or affects only some special part*. Through such interaction the organism is made a unit and acts as one because the activities of its parts are correlated" (pp. 15, 16). In the complex economy of plants, in the absence of a nervous system, chemical messengers furnish the sole means of interaction. But they are no less important in animal economy, as is adumbrated in the effects on growth and proportion of such ductless glands as the pituitary body and the thyroid and parathyroid glands.

The author gives but scant attention to the experimental work on 'unit characters' since Mendel. We are told that "an accurate examination shows the untrustworthiness of any such simple or naïve view as that of unit characters" (p. 290). He refers approvingly to Mathews, in connection with the bearing upon heredity of the internal secretions or chemical messengers in the body. "The internal secretions of the body appear to Mathews to constitute strong evidence

against the existence of such things as inheritance by means of structural units in the germ which represent definite characters of the body. We see in the internal secretions, he observes, that *every character in the body involves a large number of factors (i.e., determiners)*. The shape and size of the body, the coarseness of the hair, the persistence of the milk-teeth, a tendency toward fatness—all these may easily depend on the pituitary body, on the thyroid, and on the reproductive organs, and these—in their turn—are but the expression of other influences played upon them by their surroundings and their own constitution" (p. 290). The apparent results of the theory of 'unit characters' are due to the fact that the experiments have been performed on comparatively simple forms of life such as the pea where we lack the perspective furnished by vertebrate paleontology. The relation between heredity predispositions and body characters is more complex, at any rate, than such a theory would indicate. "A very large number of characters spring, not from the visible ancestral body forms, but from invisible predispositions and tendencies in the ancestral heredity chromatin. For example, all the radiating descendants of a group of hornless mammals may at different periods of geologic time give rise to similar horny outgrowths upon the forehead" (p. 242).

At best, however, a theory of evolution (including that expounded by the author) based upon individual characters with their individual rate of movement, is strained to the breaking point, convenient though it may be for descriptive purposes. The author adopts the obscure concepts of physical science, such as 'latent' and 'potential,' to make intelligible the supposed dormant existence of such characters, sometimes for geologic ages. But he himself is keenly alive to the danger of transposing concepts from the mechanical realm to that of organic origins and evolution. It would seem as though the key to creative evolution in the lower stages of life might rather be found in the manifestations of life in the higher stages of evolution. Just because life is, as the author so well shows, a unique type of creative synthesis, the fundamental laws of life, once it exists, must be stated in terms of life itself. What seems clear is that life is a process of creative synthesis, determined in part by internal and in part by external conditions. It has a logic of its own in which both the cumulative set of the heredity basis (whatever it is) and the external situation (including the somatic, physical and life environments) figure as factors. On the basis of this logic there is unconscious experimentation toward adaptive ends in which nature manifests creative genius in the lower stages of life (and infra-life) as truly as on the higher

conscious stages. Such creativeness is greatly facilitated and becomes more meaningful with the capacity for abstract thought and the inter-subjective medium of speech, but the essential laws of creativeness are rooted in the organic (and cosmic) process, and to its unconscious logic and experimentation we are in the last analysis subject for our further biological development or elimination. A further study of instinct, which is admittedly both organic and intelligent, with its experimentation toward adaptive ends and the crystallization of the results into organic structure, may furnish a bridge between general organic creativeness and its specialized form in human intelligence.

J. E. BOODIN.

CARLETON COLLEGE.

The Philosophy of Plotinus. The Gifford Lectures at St. Andrews, 1917-1918. By WILLIAM RALPH INGE. New York, Longmans, Green & Co., 1918.—Vol. I, pp. 270; II, pp. 252.

That Dr. Inge is Dean of St. Paul's Cathedral guarantees that he is the heir of the best traditions of English scholarship; and to this we may add that his qualities of mind and heart endear him to us as a genuine idealist, a dreamer of the good, the true and the beautiful. He is at his best in the chapter on the third century's literary (pp. 33-35) and religious (pp. 35-70) conditions. The chapter on the Soul is charming. The "Spiritual World as a Kingdom of Values" is inspiring, intoxicating, elevating, modern, and prophetic. He sets forth the soul's three paths to God (II, 104): that of Perfection (p. 125), of Beauty (p. 122), and of Dialectic (p. 105) in the following brilliant words: "We have seen that Goodness, Truth and Beauty are the attributes of Spirit and the Spiritual World. They are the three objects of the soul's quest. They may be represented as the three converging pathways which lead up to the hill of the Lord; and they furnish three proofs. The spiritual world *must* be,—this is the conclusion of the dialectic, which convinces that the idea of plurality implies that of unity, that of imperfection, a perfect. It *ought* to be,—this is the claim of the ethical sense. *It is*,—this is the discovery of direct experience or intuition, made by the soul yearning in love for its heavenly home."

Some of the best sections of the book are on æsthetics, in which Dean Inge notices the theories of Croce, of energy-values; and on religion, in which he studies prayer, the genius, and the "vision of God." But in his study of Plotinus's ethics he is very weak, omitting the study of happiness, the ecstasy, and the virtues. Mr. G. R. S.